JOURNAL OF RESEARCH ON TECHNOLOGY IN EDUCATION, *39*(2), 205–223

Student Characteristics, Sense of Community, and Cognitive Achievement in Web-based and Lab-based Learning Environments

Richard C. Overbaugh
Old Dominion University

ShinYi Lin
Ching Kuo Institute of Management and Health

Abstract

This study investigated differential effects of learning styles and learning orientation on sense of community and cognitive achievement in Web-based and lab-based university course formats. Students in the Web-based sections achieved higher scores at the "remember" and "understand" levels, but not at the "apply" or "analyze" levels. In terms of learning style, extrovert students outperformed introvert students in the lab-based sections, whereas introverts performed better in the Web-based sections. With regard to sense of community, students in the Web-based environment had higher scores on two of three scales. The final aspect examined was students' variable orientation toward learning, with significant but weak results. (Keywords: learning style, learning orientation, sense of community cognitive achievement, learning environment.)

INTRODUCTION

The primary goal of post-secondary education is to provide effective instruction, but the now widespread implementation of distributed education and the resultant competition for enrollment has increased the focus on student satisfaction, the importance of which is underscored by its inclusion as one of the Sloan five pillars of excellence (Moore, 2002). Some suggest that student satisfaction results from quality instruction; quality instruction is that which takes into account various learner characteristics. From an instructional design point of view, this is known as "audience analysis" and is a standard step in the instructional systems development (ISD) process (e.g., Dick, Carey, & Carey, 2005; Morrison, Ross, & Kemp, 2001). This study might be considered a type of audience analysis because a group of urban university students is examined to identify whether or not specific student characteristics can be identified that have the potential to contribute to subsequent instructional design decisions to improve learning efficiency and thus student satisfaction. The sample is composed of both lab-based and Web-based students, and knowledge acquisition is parsed into four cognitive levels—remember, understand, apply and analyze (Anderson & Krathwohl, 2001).

Problem-based Learning and Higher Order Thinking

Concurrent with the emergence of distributed education is the return of problem-based pedagogy, partially fueled by instructional technology that holds promise of enabling more efficient instructional designs. Problem-based learning is a strategic pedagogy designed to equip students with the ability to think at higher cognitive levels such as Bloom's Analyze, Evaluate and Create (Anderson & Krathwohl, 2001) or Merrill's "Find" Concepts, Procedures and/or Principles (Merrill, 1994) by shifting the instructional emphasis from product to process (Hanney, 2005) and more specifically to processes with open-ended outcomes based on real life problems (Savin-Baden, 2003). Creating such a learning environment online is challenging but the potential for meaningful interaction makes asynchronous learning especially attractive (Hazari, 2004). In addition, using Bloom's Taxonomy as a guide to assess higher order thinking has been field tested empirically and turned out to be a satisfactory measure in college settings (e.g., Bissell & Lemons, 2006).

Sense of Community

Recent trends have re-emphasized the development of "learning communities" in order to increase learning and student satisfaction (Moore, 2002). Learning communities or academic learning communities are based on social and affective learning theories (e.g., Gunawardena, 1995; Lickona, 1991; Kamradt & Kamradt, 1999; Vygotsky, 1978) and place an emphasis on cooperative learning (e.g., Collins, 1998; Garrison, Anderson, & Archer, 2000; Rovai, 2000 & 2002a) to advance collective knowledge and, therefore, support the growth of richer individual knowledge. The underlying premise of a learning community is a culture of learning in which everyone interacts in a collective effort of understanding (Anderson, 2003; McInnerney & Roberts, 2004; Woods & Baker, 2004). Such a learning community capitalizes upon the diversity of expertise of its members, who contribute knowledge to the benefit of the community. In addition, the increasingly diverse multiculturalism possible through the advent of new collaborative communication technologies requires learners to interact and work toward a common goal in an environment in which all contributions are respected and diverse solutions are synthesized

Rovai (2002b) developed the Classroom Community Index (CCI) to assess the degree to which students feel that they are part of a learning community, ostensibly because of the importance of socialization. Rovai's research with the CCI has identified differences in Sense of Community in different learning situations (e.g., Rovai, 2001) which enabled him to make instructional design suggestions for enhancing classroom community (Rovai, 2002a, 2002b). In Rovai and Ponton's (2005) study on examining classroom community in asynchronous learning network (ALN) courses between African American and Caucasian graduate students, he commented that fostering a sense of community should not be solely dependent on instructors; instead, students who are academically mature are capable of creating their own mechanism (e.g., study groups, e-mail contact, phone conversation) that would foster cohesion and a shared sense of values.

Learning Styles

Learning style is often examined as a potentially useful indicator of how individual differences might affect the efficacy of distributed learning (Allen, Bourhis, Burrell, & Mabry, 2002; Collinson, 2000; Fahy & Ally, 2005; Hickcox, 1995; Parkinson, Greene, Kim, & Marioni, 2003). The Myers-Briggs Type Indicator (MBTI), a self-report questionnaire, is one of the most popular instruments for personality assessment (Boyle, 1995). The MBTI, based on four theoretical constructs devised by the Swiss psychoanalyst, Carl Jung, was designed to assess personal preferences in four dimensions—perception, decision-making, social interaction, and environment interaction (Duck & Ogden, 1990). These four dichotomous dimensions classify individuals as (a) introvert (I) or extrovert (E), (b) sensing (S) or intuitive (N), (c) thinking (T) or feeling (F), or (d) judging (J) or perceiving (P). Combinations of the four preferences determine personality types represented with four letters, one from each pair (e.g., ESTP, ENFP). The first dimension is concerned with an individual's attitude toward others, the second with how an individual absorbs information, the third with how an individual makes decisions, and the fourth assesses the relative importance of the second and third dimensions (Davison, Bryan, & Griffiths, 1999). The Paragon Learning Style Inventory (PLSI) is based on the same four Jungian dimensions as the MBTI and provides a reliable indication of learning style and cognitive preference. Because the PLSI has been shown to be successful with university-level students (e.g., Tasker et al., 2003; Yeung, Read, & Schmid, 2005) it was chosen over the MBTI for this study for financial reasons.

Learning Orientation

The Learning Orientation Model (LOM) (Martinez, 1999), was designed specifically for distributed learning environments and categorizes learners into one of four types—(a) transforming, (b) performing, (c) conforming, and (d) resistant. Transforming learners are highly motivated, passionate, and committed. Performing learners are self-motivated in learning situations that interest them, but seek extrinsic rewards for learning tasks they perceive as less valuable or require more effort than they are initially willing to commit. Conforming learners are generally more compliant and willing to passively accept, store, and reproduce knowledge and are challenged to learn in open learning environments. Resistant learners may not believe that academic achievement can help them reach personal goals or initiate positive change. These categories represent the way students react to particular learning environments and associated pedagogy. Therefore, determining the learning orientation of students in this study allows for the examination of the role learning orientation might play in achievement and sense of community in Web-based vis-à-vis face-to-face learning environments.

RESEARCH DESIGN

This study is based on the premise that students learn differently because of characteristics they bring to any given learning situation and that result from exposure to specific learning strategies and environments. The four dichotomous Jungian dimensions assessed by the PLSI are inherent learning styles and therefore may be important to know so instruction can be designed to address those styles. Learning orientations, on the other hand, are characteristics that are changeable as students react to particular learning situations and therefore may be useful for adjusting instruction "on the fly," or, when looking back to how specific learners performed in a particular learning situation may identify how the instruction may be modified to better meet the needs of students with varied learning orientations. The third factor in this study is sense of community, which develops based on the learning environment but also is affected by the characteristics of the individual. Therefore, the factor of course format is utilized as a design base to examine these variables and their possible interrelationship among the factors (see Figure 1). Finally, because the goal of education is learning, achievement is examined at different cognitive levels to try to tease out differences that might occur for various learner characteristics at four different levels as described by Bloom's taxonomy—remember, understand, apply, and analyze (Anderson & Krathwohl, 2001).

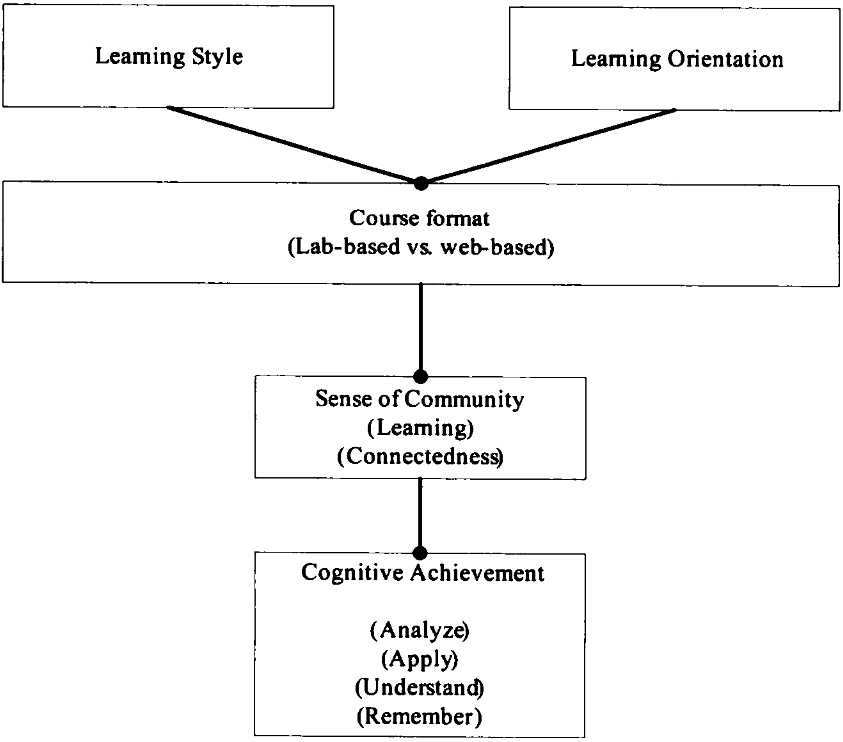


Figure 1. Theoretical framework

Does course format have a role in differential levels of cognitive achievement? The first question was intended simply to look at student achievement at four levels—(a) remember, (b) understand, (c) apply, and (d) analyze in two different course formats—(a) lab-based and (b) Web-based. Because of the importance of higher-level thinking for problem solving, examining the four cognitive levels will help determine the effectiveness of the particular instructional design utilized in this study.

Because one rationale for audience analysis is that different students perform differently in different learning environments, the second question, *What is the effect of learning style and learning environment on cognitive achievement?*, was intended to begin to identify what types of students excelled or did not excel in the two learning environments to determine the validity of the course pedagogy.

While much of the literature points to the importance of academic community to enhance learning, particularly in online environments, the authors question whether community is important to all types of learners. This notion is supported by various learning inventories such as the Introvert-Extrovert continuum in the Myers-Briggs Type Index (Myers, McCaulley, Quenk, & Hammer, 1998) and the Active-Reflective Continuum in Felder & Solomon's (2002) Index of Learning Styles inventory. Therefore, the third research question was, *What effect do learning style and learning environment have on sense of community?*

The first three research questions examine learning styles whereas the fourth question takes a different approach by looking at characteristics that are based on learner reaction to particular learning environments and instructional strategies. Therefore, the final question, *What is the relationship between students' learning orientation and cognitive achievement in two different learning environments?* investigates the predictive value of the Learning Orientation Questionnaire (LOQ) (Martinez, 1999).

METHOD

Sample

The convenience sample consisted of 67 undergraduate teacher education students enrolled in a third-year level Applications of Instructional Technology course at a large mid-Atlantic urban university who completed pre- and post-treatment surveys. Thirty-seven students were enrolled in two sections of a Web-based version of the same course. All students in the lab-based sections had the option of taking online sections whereas not all online students were able to enroll in face-to-face sections because of distance or other obstacles. The data collection did not differentiate who had a choice. The same instructor taught all sections. Students were asked to participate in the surveys and a small number of points (to be added to the semester total) were awarded to students who completed both the pre- and posttest. Two students in the lab-based and three students in the Web-based course did not participate in both data collections.

Instruments

Learning style. The Paragon Learning Style Inventory (PLSI) is a 48-item survey that provides a reliable indication of learning style and cognitive preference based on the same Jungian dimensions as the Myers-Briggs Type Indicator (MBTI) (Shindler, 2000). Each question provides a single stem and two dichotomous answers (e.g., When you get done with an assignment: a) you feel like showing it to someone; b) you like to keep it to yourself). The four dimensions are used to block students dichotomously into four learning domains: (a) introversion-extroversion, (b) intuition-sensation, (c) thinking-feeling, and (d) judging-perceiving learners. The split half reliability of each of the dimensions is between .90 and .94 for the PLSI (Shindler, 2000), and is appropriate for ages nine to adult. The instrument is available online for individual use with immediate feedback, but the author granted permission for the instrument to be coded into an online survey that collected responses into a database for statistical analysis.

Learning orientation. The Learning Orientation Model (LOM) (Martinez, 2001) outlines ranges on a continuum for four dominant learner-difference profiles which represent an individual's approach to learning: (a) Transforming Learners, (b) Performing Learners, (c) Conforming Learners, and (d) Resistant Learners. The LOQ, used with permission of the author, includes 25 seven-level Likert-type questions, such as: "I look for additional information sources that help me learn about new topics; (b) My personal goals have priority over the instructor's course objectives, and (c) I know what to do if I am not doing well in a course. The reliability of the LOQ by Martinez (2005) in several tests resulted in ranges from .80–.87. Our data reported a reliability of .73. Forbes & Ross (2003) reported reliability of .70 or above is considered acceptable for attitude scales.

Sense of community. The Classroom Community Index (CCI) (Rovai, 2002a) was used to measure students' sense of community at the beginning and end of the course. Twenty Likert-type items provide an overall Sense of Community score ($\alpha = .93$) and two subscales, connectedness ($\alpha = .92$) and learning ($\alpha = .87$). The instrument, used with permission of the author, includes 20 seven-level Likert-type items, such as: (a) I feel that students in this course care about each other; (b) I feel reluctant to speak openly; and (c) I feel uncertain about others in this course.

Cognitive Achievement. Of particular interest to this study was the level of cognitive engagement reached by students based on the first four levels of Bloom's (revised) taxonomy (Anderson & Krathwohl, 2001). Content quizzes were designed to assess student knowledge at various levels in order to measure how far up the hierarchy students were able to demonstrate knowledge acquisition. Sample questions were, (a) *Which of the three learning theories [in the unit of study] is considered "child-centered?"* (remember), *Why?* (understand); (b) *Because of your computer expertise you have been awarded a contract (for big $$$) to teach a school faculty how to use databases for administrative purposes. By the end of the instruction, the faculty should be able to create a personal database of student information and query the database. Briefly, how would you incorporate all three learning theories into your instruction (use examples of activities to support your answer)* (apply); and (c) *Select at least two different learning activities in your academic past or present that seemed to use an inappropriate learning theory. Do two things: 1) describe the activity and learning theory it is/was based upon, and 2) discuss the learning theory you believe would have been more appropriate and why.* (analyze).

The three survey instruments—PLSI, LOQ, and CCI were administered at the end of the second week of the semester and again two weeks before finals

Table1: Descriptive Summary of Mean Percentage of Cognitive Achievement Versus Course Format

☐	Course Format			
	Lab-based		Web-based	
☐	*M*	*SD*	*M*	*SD*
Remember	.74	.22	.88	.16
Understand	.70	.19	.80	.21
Apply	.56	.37	.60	.36
Analyze	.56	.35	.55	.38

(week 14). The learning assessment scores were compiled from three project quizzes throughout the semester.

Treatment

The course was a nine-module foundations course on integrating instructional technology into the classroom. Rather than the typical skill-type course where students learn productivity software, Web-based resources and multimedia presentation skills, the treatment required students to have basic computing skills as a prerequisite. Significant effort has been made to develop the course into a theoretically grounded course in which contemporary and traditional learning theories provide a framework for the development of strategies to use basic instructional technology applications and devices to enhance teaching. The current version of the course is the result of collaboration between professional, university instructional design staff and the course instructor to develop a Web-based version, which due to its success was then adopted as the pedagogy for the lab-based course. The instructor has taught the course for more than a decade and served as the subject matter expert. Both the lab-based and Web-based sections follow the same schedule and use the same materials and corresponding assessments. See appendix for the course planner/schedule.

ANALYSIS AND RESULTS

Course Format Versus Cognitive Achievement

To answer the first research question, a multivariate analysis was utilized with course format as a factor to compare student achievement on questions designed to assess knowledge at four cognitive levels: (a) remember, (b) understand, (c) apply, and (d) analyze, as dependent variables. The results showed significantly higher achievement by the Web-based students at the remember level (Lab $M = .74$ versus Web $M = .88$), $F(1, 61) = 8.70$, $p < .01$, and understand level (Lab $M = .71$ versus Web $M = .80$), $F(1, 61) = 4.09$, $p < .05$, but not at the apply or analyze levels (See Table 1). Figure 2 clearly illustrates the differences at the first two levels and the drop in means and lack of difference at the upper cognitive levels. In addition, as reported in the MANOVA analysis, the Wilk's Λ of .82 is significant, $F(1, 61) = 3.14$, $p < .05$, indicating mean scores at the

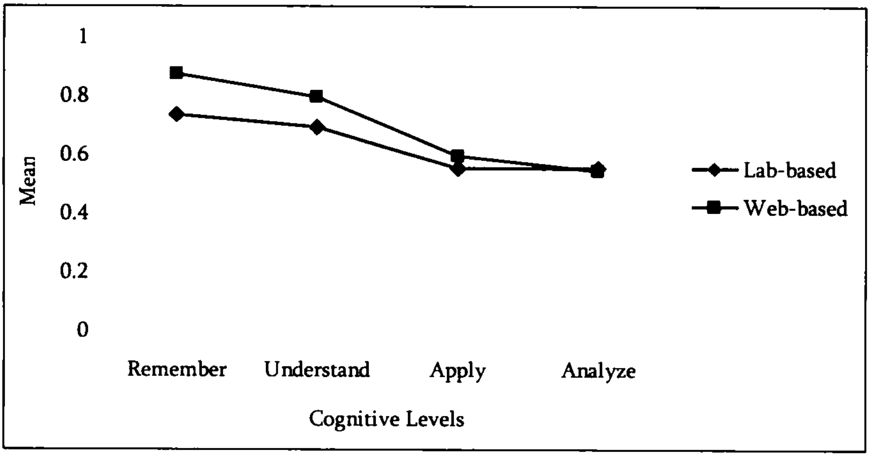


Figure 2. Percentage of mean score at the four cognitive levels in the two course formats

four cognitive levels are distinct between the lab-based and Web-based course format. The multivariate η^2 of .18 indicates 18% of multivariate variance of cognitive achievement is associated with the course format.

Learning Style Versus Course Format on Cognitive Achievement

The next analyses were intended to begin to burrow further down into achievement to see if learning might be affected by the learning styles students bring with them to the classroom and whether the two learning environments might also have an effect. Therefore, the second question was answered through four series of one-way ANOVAs to systematically examine achievement by the four learning style dimensions of the Paragon Learning Styles Inventory—(a) introvert-extrovert, (b) sensate-intuitive, (c) feeler-thinker, and (d) judger-perceiver in the two learning environments—lab-based versus Web-based, and the four cognitive levels. The separate analyses were conducted because (a) Jungian theory indicates that one's score on each dichotomous dimension reflects fundamental differences between discreet domains (Boyle, 1995) and therefore research that examines the domains in isolation is not uncommon (see, for example Duck & Ogden, 1990; Ullman-Petrash, 2000) and (b) achievement at each of the four cognitive levels might lead to specific instructional strategies for different level learning objectives. The first series of ANOVAs showed only a main effect between course format and cognitive levels at the remember and understand levels as found in the first research question analysis and is therefore not particularly interesting. The second series showed two interactions at the apply level for the introvert-extrovert and judger-perceiver dimensions. For the extrovert-introvert dimension, extroverted students performed better in the lab-based sections than the introverted, whereas the introverted performed better in the Web-based sections, $F(1, 54) = 4.92, p < .05$ (See Figure 3). At the judger-perceiver dimension, the Judgers performed equally well in both course formats, but the perceivers dropped dramatically in the Web-based format, $F(1, 54) = 3.60, p < .05$ (See Figure 4).

Learning Style Versus Course Format on Sense of Community

The third question was answered through a series of MANOVAs with PLSI domain and course format as factors and the three Classroom Community Scales (Connectedness, Learning, and CCS Total) as dependent variables. The results showed main effects between course format and CSS, but there were no interaction effects with the PLSI domains. Therefore, one-way ANOVAs were then conducted as follow-up tests to compare the two course formats on each of the three Sense of Community scales. There were significant differences in the Learning subscale, $F(1, 191) = 6.02, p < .05$, and CCS Total subscale, $F(1, 191) = 4.40, p < .05$ which show that students in the Web-based environment tended to perceive higher levels of learning and that they felt more involved in the classroom community (See Figure 5).

Learning Orientation Versus Cognitive Achievement in Two Course Formats

To answer the final question, multiple regressions were conducted to evaluate the usefulness of the Learning Orientation Model. The pretest LOQ was used

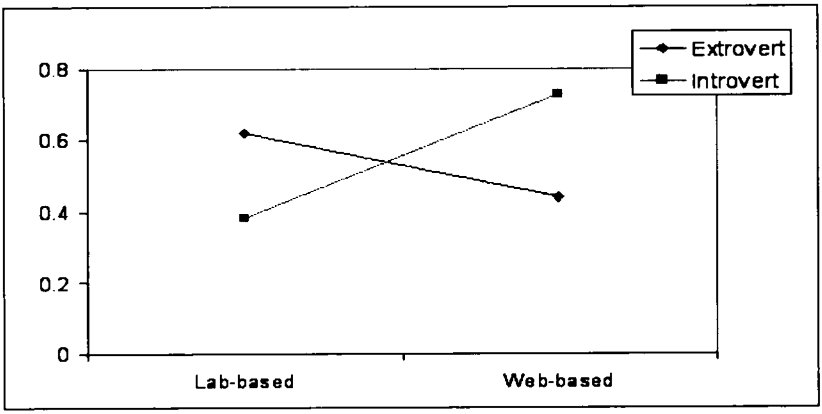


Figure 3. Disordinal interaction of course format versus extrovert-introvert dimension

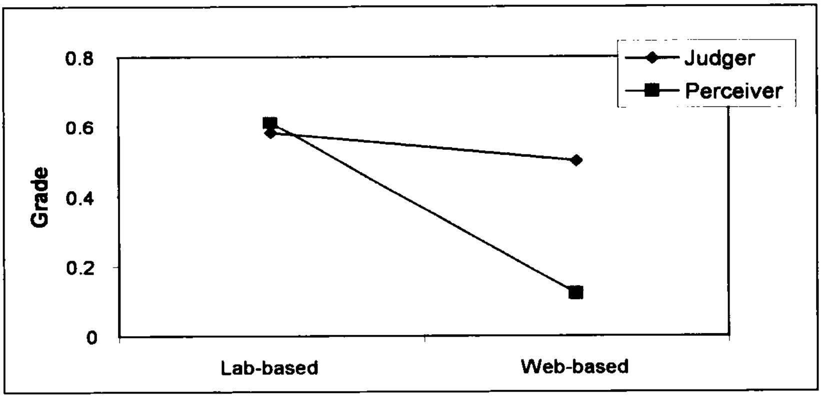
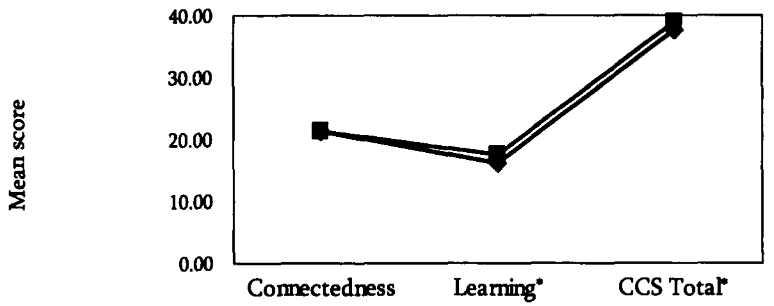


Figure 4. Disordinal interaction of course format versus judger-perceiver dimension



	Connectedness	Learning*	CCS Total*
lab-based	21.25	16.20	37.46
web-based	21.23	17.58	38.81

Figure 5. Ordinal effect of course format in the learning and total CCS subscales of sense of community (p<.05)*

to identify any relationships between the orientations students brought with them to this particular learning situation to determine the viability of using the LOQ instrument to devise instructional interventions for improved learning. The posttest LOQ scores were also evaluated to see if the design of this particular course effected any change in the students in order to explore whether or not students had changed and thus be differentially prepared for future classes.

As shown in Table 2, multiple regression analysis reported that the apply cognitive level was significantly predicted by the LOQ pretest ($\beta = .42, p < .05$), while the LOQ posttest substantially predicted the analyze level ($\beta = .40, p < .05$). The coefficients of multiple determination (R^2) for each cognitive level are .24 for remember, .06 for understand, .15 for apply, and .29 for analyze. R^2 yields a value that presents the proportion of variation in the dependent variable that is explained by the predictor variables. In addition, ANOVA follow-up tests showed that an interaction occurred in the apply domain: Performing students achieved lower apply scores in Web-based courses than lab-based courses, whereas, conforming and transforming students achieved higher scores in Web-based courses than lab-based courses.

DISCUSSION

Course Format and Achievement

One of the more interesting results of this investigation is the difference in achievement between the lab-based and Web-based students at the remember and understand levels, but not at the apply and analyze levels. Notably, the scores on the higher levels—apply and analyze—were in the failing range for both groups. Initially, these results might be interpreted as somewhat disappointing, largely because the course was designed as a project-based, generative learning experience with students responsible for active learning. Nonetheless, these findings are valuable; even though the pedagogy included collaborative activities, those activities were neither continual or cumulative and thus did

Table 2: The Results of the Multiple Linear Regression Analysis of a Set of Predictors to the Dependent Variables

		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
Cognitive Levels		B	Std. Error	Beta		
Remember	(Constant)	.44	.19		2.27	.03
	Course Format	.11	.07	.26	1.63	.11
	LOQ Pretest	.06	.07	.16	.87	.39
	LOQ Posttest	.05	.06	.16	.86	.40
Understand	(Constant)	.82	.18		4.64	.00*
	Course Format	.10	.06	.26	1.60	.12
	LOQ Pretest	-.11	.07	-.32	-1.68	.10
	LOQ Posttest	.07	.05	.26	1.35	.19
Apply	(Constant)	-.02	.36		-.06	.95
	Course Format	-.08	.12	-.11	-.68	.50
	LOQ Pretest	.31	.14	.42	2.24	.03 *
	LOQ Posttest	-.08	.11	-.13	-.68	.50
Analyze	(Constant)	-.16	.36		-.45	.66
	Course Format	.08	.12	.10	.62	.54
	LOQ Pretest	.00	.14	.00	.01	.99
	LOQ Posttest	.24	.11	.40	2.13	.04 *
Predictors: (constant), course format, LOQ pretest, LOQ posttest						
Dependent Variable: Remember, understand, apply, analyze cognitive levels						

*$p < .05$

not generate enough student-to-student interaction (Moore, 1989) to result in adequate social presence (Garrison, Anderson, & Archer, 2000) which can contribute to higher learning levels of knowledge construction or critical self evaluation (Salmon, 2000). Additional insight was gained two ways. The first was by talking with the graduate lab staff (education majors who worked for one of the researchers) who served as a course "help desk" for both lab-based students and Web-based students (via phone and e-mail), and by directly talking to students working in the lab and second, by questioning the course instructor. These conversations indicated that this course was the students' first experience with online learning as well as generative pedagogy and that they were uncomfortable with it. This is supported by the clear need—expressed by the instructor—for a much higher level of reassurance that students are "on the right track" in the course activities which is considered an aspect of teaching presence (Garrison, Anderson, & Archer). Also important is the instructor's clear indication that much more time was spent answering Web-based students' individual questions. Perhaps this supports the need for focused student orientation to various types of online discourse to prepare them to maximize their learning, which is consistent with Wozniak's (2005) work that finds orientation enables students to more easily reach higher levels of cognition and reduces the time instructors need to spend mediating online discourse.

On the other hand, the course is a foundation-level course intended to teach skills and knowledge that will be built upon in the methods and materials classes. Notably, this course focused on the use of instructional technology to enhance the teaching/learning process in the PK–12 classroom. Each of the course modules included activities to apply content knowledge to classroom practice, but perhaps these findings show that these students have insufficient knowledge bases and/or intellectual skill to creatively transfer theory into practice, a process which leads to higher level learning (Salmon, 2000; Wozniak, 2005). We hope that these students will be ready to explore, learn, and implement the various uses of technology throughout the remainder of their professional education courses. An interesting follow-up would be to follow these individuals as they move into subsequent courses with similar instructional designs to see if higher-level achievement improves.

Learning Styles, Achievement and Course Format

A primary motivation for this study was the desire to find out if student differences have an effect on student success in the two different course formats. This study, rather than compare different instructional designs, utilized a course designed by expert distributed-instruction design staff at the university and began a systematic investigation to determine whether or not student differences might have an effect on achievement based on that specific instructional design. In this case, student differences are the four Jungian dimensions measured via the Paragon Learning Styles Inventory (PLSI) (Shindler, 2000), and these dimensions were further delimited by the four cognitive levels. While largely insignificant results were found, there were two notable interactions.

The first showed that students classified as extroverts performed better at the apply level in a traditional setting than they did in the Web-based format, whereas introverted learners performed better in the Web-based section than they did in the traditional course format. Intuitively, this makes sense: A comparison of the characteristics of Web-based vis-à-vis the traditional course format, the Web-based format is typically asynchronous and the traditional course format is synchronous. Introverts are fond of working alone and reflecting on their learning quietly to link knowledge chunks into meaningful wholes (Fox-Hines & Bowersock, 1995) which makes the Web format intuitively more suitable (Neuhauser, 2002). In contrast, extroverts tend to like to learn via discussion with peers and to work in groups, a setting in which they can put forth their interpretation of their learning, which in turn allows them to make sense of their new knowledge (Quenk, 1999).

The second interaction showed differential achievement by students classified as either judger or perceiver by the PLSI. Again, at the apply level, the judgers achieved equally well in either the lab-based or Web-based environment, but the perceivers did much more poorly in the Web-based environment. This result may be because perceivers tend to learn better if immediate feedback is provided—a condition inherent in synchronous traditional course formats. However, perceivers tend to procrastinate (Quenk, 1999) and will likely do so in asynchronous learning environments, which require self-regulation for success. On the other hand, judgers seem to pay more attention to course structure and order, which might be construed to mean that they may do equally well in Web-based or traditional course formats as long as structure and requirements are strong. Importantly, extreme caution is advised as this sample included only six perceivers. Further investigation is needed to ascertain whether or not this is truly a trend.

Learning Styles and Sense of Community

Contrary to expectations, learning styles had no effect on Sense of Community levels. This question was posed for two reasons. The first is that current instructional design discussions often refer to the need for a high sense of belonging, or sense of community to learn from students' social interaction (Shea, 2006). The second reason is that the authors question the need for a sense of community for *all* learners; perhaps certain personality types don't want (even though they might benefit) or need socialization for increased learning. The lack of any significant results may indicate that the Paragon Learning Styles Inventory does not provide suitable dimensions for teasing out student differences as related to sense of community.

However, that the Web-based students showed a higher Sense of Community on the perceived learning subscale as well as overall sense of belonging to the academic community is noteworthy. This might indicate that, if one accepts that lab-based courses naturally lead to levels of community that students perceive as adequate, then for this particular sample and subject area, efforts to provide additional social learning opportunities (cooperative learning, group projects, discussion boards, etc.) may not be necessary. This makes sense because the courses did provide for a variety of opportunities to contribute to community learning aspects, and therefore perhaps all types of students were able to participate in a fashion in which they were most comfortable, therefore leading to perceived satisfactory levels of sense of community even though little effort was expended to include activities intended to purposely foster community building. Supporting this line of reasoning is that synchronous discourse occurred in class for the lab-based students, but was also available to the Web-based students via an instructor-hosted chat group held twice weekly. In addition, four projects included group chat requirements. Also important is that, as described above, the Web-based course took more of the instructor's time, which might explain why sense of community was equal or somewhat elevated. In other words, the extra effort by the instructor to have online teaching presence may have been more successful with the Web-based students than with those in the lab-based course which is consistent with other research (e.g., Fredericksen, Pickett, Shea, Pelz, & Swan, 2000; Shea, 2006; Song, Singleton, Hill, & Koh, 2004). However, whether or not the level of community in both course types is adequate remains questionable; if better achievement at the higher cognitive levels, as discussed above, is a goal then perhaps the amount, type, and focus of student collaboration needs to be increased to meet that goal (Salmon, 2000; Uribe, Klein, & Sullivan, 2003; Wozniak, 2005).

Learning Orientation and Achievement

The findings regarding students' learning orientation quotient are interesting. The LOQ (Martinez, 1999) was designed to provide guidance for students engaged in distributed learning situations. This study utilized the instrument in both lab-based and Web-based course formats. LOQ scores were gathered at the beginning and the end of the semester because the scores are claimed to be differentially variable based on the situation. Therefore, pretreatment LOQ scores should theoretically predict success in the course, whereas, post-LOQ scores should predict success on subsequent treatments, although one would expect the indicator to be restricted to subsequent courses with similar instructional designs.

The pre-treatment LOQ scores were positively related to apply-level scores for all students, indicating course format was not a factor. However, it appears that students with lower LOQ scores are not achieving satisfactorily at the apply level with this particular instructional design. This is meaningful because application is a higher cognitive level and the course designers attempted to demand higher levels of achievement from the students. Nonetheless, the researchers are encouraged by the findings, as the LOQ provides to students recommended strategies to improve their achievement.

Finally, that students' LOQ scores can be situationally different was verified; among the three classifications—conformer, performer, and transformer, shifts occurred over the course of the instruction. Ideally, all shifts should be upward but this study showed almost an equal number of students moving up or down, simply proving that students do indeed change in reaction to particular learning situations. Martinez (2000) intended that students be apprised of their scores and, subsequently shown ways to address their learning strategy strengths and weaknesses in order to be more successful but, in this study, students were not given their orientation classification nor did the instructional strategies take into account different learning orientations.

CONCLUSIONS

The instructional design of the courses can be considered successful in terms of overall course grade (grades were typical for this level university course) but this study was based on content assessments that specifically looked at learning hierarchically, which we believe is a more accurate look at learning. Using those measures, achievement was slightly higher for online students, at least at the remember and understand levels. Notably, all sections were taught by the same instructor, who attempted to homogenize instruction for both formats as much as possible. The minimal differences in achievement indicate that nearly equivalent instruction can be achieved, but in this case, shows that the Web-based sections take far more time than lab-based classes. Future efforts to reach higher achievement on higher cognitive-level knowledge will be the primary challenge. The way to reach this goal may be to redesign course activities to develop a stronger academic community. Interestingly, because the results show this to be true for both lab-based and Web-based courses an additional direction will be to provide a stronger orientation to this type of pedagogy so that students are better prepared to engage in the collaborative activities. This may be particularly true because, in this situation, the overall program lacks pedagogical unity and consistency and thus makes this progressive, problem-based approach even more problematic to the students. Raising the cognitive requirements will also allow future research to see if the patterns that are only beginning to emerge in this study will strengthen and expand. In sum, while no strong predictors of achievement by student differences emerged from this effort, the weak relationships that did will guide further research. This study was intended to begin defining parameters for the study of differential achievement based on student differences that will eventually provide information to guide the instructional design of future courses to meet the needs of more types of students. We believe that goal was achieved and we will continue to refine data collection and assessments.

Contributors

Richard Overbaugh is associate professor of Darden College of Education at Old Dominion University, Norfolk, Virginia. (Address: Richard Overbaugh, 145 Education, Old Dominion University, Norfolk VA, 23529; roverbau@odu.edu).

ShinYi Lin is assistant professor of the Department of Information Technology at Ching Kuo Institute of Management and Health inTaiwan. She received her PhD in Urban Education/ Educational Technology from Old Dominion University, Virginia, USA. Her research interests include instructional strategy and distributed learning in adult education. (Address: ShinYi Lin, 336 Fu-Hsing Rd. Keelung, Taiwan 203, ROC; slin@ems.cku.edu.tw).

References

Allen, M., Bourhis, J., Burrell, N., & Mabry, E. (2002). Comparing student satisfaction with distance education to traditional classrooms in higher education: A meta analysis. *The American Journal of Distance Education, 16*(2), 83–97.

Anderson, T. (2003). Getting the mix right again: An updated theoretical rationale for interaction. *International Review of Research in Open and Distance Learning.* Retrieved July 12, 2005, from http://www.irrodl.org/index.php/irrodl/article/view/186/268

Anderson, L. W., & Krathwohl (Eds.). (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives.* New York: Longman.

Bissell, A. N., & Lemons, P. P. (2006). A new method for assessing critical thinking in the classroom. *BioScience, 56*(1), 66–72.

Boyle, G. J. (1995). Myers-Briggs Type Indicator (MBTI): Some psychometric limitations. *Australian Psychologist, 30*(1), 71–74.

Collins, A. (1998). Learning communities: A commentary on papers by Brown, Ellery, and Campione and by Riel. In J. G. Greeno & S. Goldman (Eds.), *Thinking practices in mathematics and science learning* (pp. 79–87). Hillsdale, NJ: Lawrence Erlbaum Associates.

Collinson, E. (2000). A survey of elementary students' learning style preferences and academic success. *Contemporary Education, 71*(4), 42–48.

Davison, L., Bryan, T., & Griffiths, R. (1999). Reflecting students' learning style. *Active Learning, 10,* 10–13.

Dick, W., Carey, L., & Carey, J. O. (2005). *The systematic design of instruction,* 6th Ed. New York: Longman.

Duck, H., & Ogden, W. R. (1990). An essay on Jungian typology and its implications for education. *Educational Resources Techniques, 29*(1), 17–21.

Fahy, P. J., & Ally, M. (2005). Student learning style and asynchronous computer-mediated conferencing (CMC) interaction. *American Journal of Distance Education, 19*(1), 5–22.

Felder, R. M., & Soloman, B. A. (2002). *Learning styles and strategies.* Retrieved online http://www2.ncsu.edu/unity/lockers/users/f/felder/public/ILSdir/styles.htm

Forbes, S. A., & Ross, M. E. (2003). Reliability of scores and the researcher. *Journal of Research in Education, 13*(1), 102–109.

Fox-Hines, R., & Bowersock, R. B. (1995, January-March). ISFJ, ENTP, MBTI: What's it all about? *Business & Economic Review, 41*(2), 3–7.

Fredericksen, E., Pickett, A., Shea, P., Pelz, W., & Swan, K. (2000). Student satisfaction and perceived learning with on-line courses: Principles and examples from the SUNY learning network. *Journal of Asynchronous Learning Network, 4*(2), 7–41.

Garrison, D. R., Anderson, T., & Archer, W. (2000). Critical inquiry in a text-based environment: Computer conferencing in higher education. *The Internet and Higher Education, 2* (2/3), 87–105.

Gunwardena, C. N. (1995). Social presence theory and implications for interaction and collaborative learning in computer conferences. *International Journal of Educational Telecommunications, 1*(2/3), 147–166.

Hanney, R. (2005). Competence or capability: Work-based learning and problem-based learning. *Journal of Media Practice, 6*(2), 105–112.

Hazari, S. (2004). Strategy for assessment of online course discussions. *Journal of Information Systems Education, 15*(4), 349–355.

Hickcox, L. K. (1995). Learning styles: A survey of adult learning style inventory models. In R. R. Sims, & S. J. Sims (Eds.), *The importance of learning styles: Understanding the 112 implications for learning, course design, and education* (pp. 25–47). Westport, CT: Greenwood Press.

Kamradt, T. F., & Kamradt, E. J. (1999). Structured design for attitudinal instruction. In C. M. Reigeluth, (Ed.) *Instructional design theories and models: A* *new paradigm of instructional theory,* (pp. 563–590). Mahwah, New Jersey: Lawrence Erlbaum Associates.

Lickona, T. (1991). *Educating for character.* New York: Bantam Books.

Martinez, M. (1999). *An investigation into successful learning—Measuring the impact of learning orientation (a primary learner-difference variable) on learning.* Doctoral dissertation. Brigham Young University. Retrieved September 19, 2005, from http://www.trainingplace.com/source/research/Martinezdissertation1999.pdf

Martinez, M. (2000). Successful learning—Using learning orientations to mass customize learning. *International Journal of Educational Technology (IJET).* Retrieved from http://smi.curtin.edu.au/ijet/v2n2/martinez/index.html

Martinez, M. (2001). Key design considerations for personalized learning on the Web. *International Forum of Educational Technology & Society,* Retrieved from http://efets.ieee.org/periodical/vol_1_2001/v_1_2001.html

Martinez, M. (2005). Learning orientation questionnaire—Interpretation Manual. Retrieved September 19, 2006 from http://www.trainingplace.com/source/research/LOQPKG-Manual2005.pdf

McInnerney, J. M., & Roberts, T. S. (2004). Online learning: Social interaction and the creation of a sense of community. *Educational Technology & Society, 7*(3), 73–81.

Merrill, M.D. (1994). *Instructional design theory.* Englewood Cliffs, NJ: Educational Technology Publication.

Moore, J. C. (2002). *Elements of quality: The Sloan-Framework.* Needham Heights, MA: Sloan Center for Online Education.

Moore, M. (1989). Three types of interaction. *American Journal of Distance Education, 3*(2), 1–6.

Morrison, G. R., Ross, S. M., & Kemp, J. E. (2001). *Designing effective instruction,* (3rd Ed.(New York: John Wiley.

Myers, I. B., McCaulley, M., Quenk, N., & Hammer, A. (1998). *MBTI Manual: A guide to the development and use of the Myers-Briggs Type Indicator.* Palo Alto: Consulting Psychologists Press.

Neuhauser, C. (2002). Learning style and effectiveness of online and face-to-face instruction. *The American Journal of Distance Education, 16*(2), 99–113.

Parkinson, D., Greene, W., Kim, Y., & Marioni, J. (2003). Emerging themes of student satisfaction in a traditional course and a blended distance course. *TechTrends, 47*(4), 22–28.

Quenk, N. L. (1999). *Essentials of Myers-Briggs type indicator assessment.* New York: John Wiley & Sons.

Rovai, A. P. (2000). Building and sustaining community in asynchronous learning networks. *Internet and Higher Education, 3,* 285–297.

Rovai, A. P. (2001). Classroom community at a distance: A comparative analysis of two ALN-based university programs. *Internet and Higher Education 5,* 197–211.

Rovai, A. P. (2002a). Building sense of community at a distance. *International Review of Research in Open and Distance Learning.* Retrieved online http://www.irrodl.org/content/v3.1/rovai.html

Rovai, A. P. (2002b). Development of an instrument to measure classroom community. *Internet and Higher Education, 5,* 197–211.

Rovai, A. P., & Ponton, M. K. (2005). An examination of sense of classroom community and learning among African American and Caucasian graduate students. *Journal of Asynchronous Learning Networks, 9*(3). Retrieved on August 30, 2006, at http://www.sloan-c.org/publications/jaln/v9n3/v9n3_rovai.asp

Salmon, G. (2000). *E-moderating: The key to teaching and learning online.* London: Kogan Page.

Savin-Baden, M. (2003). *Facilitating problem-based learning.* Maidenhead: Open University Press.

Shea, P. (2006). A study of students' sense of learning community in online environments. *Journal of Asynchronous Learning Networks, 10*(1), 35–44.

Shindler, J. (2000). *Paragon Learning Style Inventory.* Retrieved March 20, 2006, from http://www.oswego.edu/plsi/

Song, L., Singleton, E. S., Hill, J. R., & Koh, M. H. (2004). Improving online learning: Student perceptions of useful and challenging characteristics. *The Internet and Higher Education, 7*(1), 59–70.

Tasker, R., Miller, J., Kemmett, C., & Bedgood, Jr., D. R. (2003). Analysis of student engagement with online chemistry modules using tracking data. In G. Crisp, D. Thiele, I. Scholten, S. Barker, & J. Baron (Eds.), *Interact, Integrate, Impact: Proceedings of the 20th Annual Conference of the Australasian Society for Computers in Learning in Tertiary Education, 2,* 505–514.

Ullman-Petrash, L. (2000). The thinking-feeling scale and the separate and connected ways of knowing. *Journal of Psychological Type, 52,* 36–40.

Uribe, D., Klein, J. D., & Sullivan, H. (2003). The effect of computer-mediated collaborative learning on solving ill-defined problems. *Educational Technology Research & Development, 51*(1), 5–19.

Vygotsky, L. (1978). *Mind in society: The development of higher psychological processes.* Cambridge: Harvard University Press.

Woods, R. H. Jr., & Baker, J. D. (2004, August). Interaction and immediacy in online learning. *International Review of Research in Open and Distance Learning.* Retrieved September 12, 2006, from http://www.irrodl.org/index.php/irrodl/article/view/186/268

Wozniak, H. (2005, November). Online discussions: Improving the quality of the student experience. Paper presented at Breaking Down Boundaries; A Conference on the International Experience in Open, Distance and Flexible Education, the 17th Biennial Conference of the Open and Distance Learning Association of Australia, Adelaide, AU. Retrieved September 7, 2006, from http://www.unisa.edu.au/odlaaconference/PDFs/61%20ODLAA%202005%20-%20Wozniak.pdf

Yeung, A., Read, J., & Schmid, S. (2005). *Students' learning styles and academic performance in first year chemistry.* Paper presented at the 2005 National UniServe Conference, Sydney, AU. Retrieved September 1, 2006, from http://science.uniserve.edu.au/pubs/procs/wshop10/2005Yeung.pdf

APPENDIX: COURSE PLANNER/SCHEDULE

Course Planner/Schedule

Students will complete the following projects by the specified due date. Specific requirements for each project are spelled out in the project section in BlackBoard.

Project	Project Topics	Start Date	Due Date	Estimated Time
1	Technology Integration into Teaching and Learning	9/2	9/9	9-12 hours
2	Overview of Learning Theories Quiz dates: 6am on 9/15 until 11pm on 9/17	9/10	9/16	9-12 hours
3	Tools: Presentation and Word Processing Due Dates: Basic Files: 9/21; Toolbox Files and Journal: 9/26	9/17	9/26	12-15 hours
4	Tools: Concept Mapping & Spreadsheet Due Dates: Basic Files: 10/1; Toolbox Files and Journal: 10/7	9/27	10/7	12-15 hours
5	Project-Based Learning Cooperative Learning (FALL BREAK 10/8-10/11) Quiz dates: 6am on 10/17 until 11pm on 10/19	10/8	10/17	9-12 hours
6	Information Literacy Fundamentals Quiz dates: 6am on 10/25 until 11pm on 10/27	10/18	10/26	9-12 hours
7	WebQuest Part 1 due 11/1, Part 2 due 11/11, Critiques due 11/14, Part 3 due 11/22	10/27	11/22	30-40 hours
8	(THANKSGIVING BREAK 11/23-11/27) Educational Software & Evaluation	11/28	12/2	9-12 hours
9	Social, Ethical, Legal and Human Issues Quiz dates: 6am on 12/8 until 11pm on 12/10	12/3	12/9	9-12 hours